

CLAIMS

1. A sheet beam based testing apparatus characterized by comprising:

a testing chamber for an object under testing;
a sheet beam generator for emitting charged particles or ions or electromagnetic waves having energy for expelling secondary charge particles from said object under testing held in said testing chamber as a sheet-shaped primary irradiation beam having a predetermined width;

an electron-optical system for introducing said beam to said object under testing, and capturing secondary charged particle flux generated from said object under testing and introducing said secondary charged particle flux to an image processing system;

the image processing system for projecting said secondary charge particle flux to form a visible image;

an information processing system for displaying and/or storing state information of said object under testing based on an output of said image processing system; and

a stage for holding said object under testing for relative movement with respect to said electron-optical system.

2. A sheet beam testing apparatus according to claim 1, characterized by further comprising a transport mechanism for securing said object under testing for transportation

into and out of said testing chamber.

3. A sheet beam testing apparatus according to claim 2, characterized in that said transport mechanism comprises:

a mini-environment chamber for supplying a clean gas to said object under testing to prevent dust from attaching to said object under testing;

a plurality of loading chambers disposed between said mini-environment chamber and said testing chamber, and adapted to be independently controllable in a vacuum atmosphere;

a first transport unit for transporting an object under testing between one of said loading chambers and said mini-environment chamber;

a second transport unit for transporting said object under testing between one of said loading chambers and said testing chamber; and

a vibration isolator for supporting said testing chamber and said loading chamber.

4. A sheet beam testing apparatus according to claim 1, characterized in that said testing chamber comprises:

a vibration isolator for preventing vibrations of said object under testing; and

a vacuum device for holding the inside of said testing chamber at a vacuum.

5. A sheet beam testing apparatus according to claim 1, characterized in that said testing chamber comprises a precharge unit for reducing variations in charging on said object under testing and/or a potential applying unit for

applying said object under testing with a potential.

6. A sheet beam based testing apparatus according to claim 1, characterized by comprising the sheet beam generator including a partition wall disposed prior to a location at which charged particles or ions or electromagnetic waves irradiated from a plurality of beam sources are introduced into said electron-optical system, said partition wall having a hole in a large aspect ratio through which said charged particles or ions or electromagnetic waves can pass.

7. A sheet beam based testing apparatus according to claim 6, characterized in that a plurality of said holes are formed for the respective beam sources.

8. A sheet beam based testing apparatus according to claim 7, characterized in that said holes are formed at positions which swerve from irradiating axes of said beam sources.

9. A sheet beam based testing apparatus according to claim 6, wherein said partition wall is formed of a material having a high rigidity.

10. A sheet beam based testing apparatus according to claim 1, characterized by having an electron-optical system including an electrostatic lens.

11. A sheet beam based testing apparatus according to claim 10, characterized in that electrodes within said electron-optical system are coated with a metal having a work function of 5 eV or higher.

12. A sheet beam based testing apparatus according to

claim 11, characterized in that said metal is platinum or an alloy of platinum.

13. A sheet beam based testing apparatus according to claim 10, characterized in that:

said electrostatic lens includes a plurality of electrodes having potential differences, and an insulating material positioned between said electrodes for holding said electrodes, at least one electrode having a first electrode surface having a minimum inter-electrode distance, a second electrode surface having an inter-electrode distance longer than said first electrode surface, and a step between both said electrodes;

said insulating material being positioned between said second electrode surface and another electrode for substantially vertically supporting each electrode; and

a minimum creeping distance of said insulating material between said electrodes is substantially equal to an inter-electrode distance in said supported electrode portion.

14. A sheet beam based testing apparatus according to claim 1, characterized by having an EXB separator or a Wien filter for separating a secondary charged particle beam emitted from said object under testing from the primary irradiating beam, wherein the amount of deflection of said secondary charged particle beam by a magnetic field of said EXB separator or said Wien filter is twice the amount of deflection by an electric field of the same, and a deflecting direction by said magnetic field is opposite to

a deflecting direction by said electric field.

15. A sheet beam based testing apparatus according to claim 1, characterized by comprising an electron-optical system for irradiating a plurality of first irradiating beams to said object under testing to emit secondary charge particles, and introducing said secondary charge particles to said image processing system.

16. A sheet beam based testing apparatus according to claim 1, characterized by comprising:

a measuring mechanism for measuring first data indicative of rising of a secondary charged particle beam signal waveform when a pattern edge parallel in a first direction is moved in a second direction in regard to an excitation voltage of an objective lens, and second data indicative of rising of the secondary charged particle beam signal waveform when a pattern edge parallel in said second direction is moved in said first direction; and

control means for approximating each of said first data and said second data using quadratics, finding an excitation condition for said objective lens indicative of a minimum value of each quadratic, and fitting said excitation voltage of said objective lens to an algebraic mean of said found excitation condition.

17. A sheet beam based testing apparatus according to claim 16, wherein said control means further comprises means for correcting astigmatism.

18. A sheet beam based testing apparatus according to claim 16, wherein:

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said objective lens comprises a first electrode applied with a voltage close to a ground, and a second electrode applied with a voltage remote from the ground; and

said sheet beam based testing apparatus comprises a control mechanism having a mechanism for changing a focal distance of said objective lens by changing the voltage applied to the first electrode, a mechanism for changing the voltage applied to said second electrode to largely change the focal distance of said objective lens, and a mechanism for changing the voltage applied to said first electrode to change the focal distance of said objective lens in a short time.

19. A sheet beam based testing apparatus according to claim 1, characterized by comprising a mechanical construction for determining a position of said object under testing at which a primary irradiating beam is emitted, a piezoelectric element for receiving a force from vibrations of said mechanical construction; and a vibration attenuating circuit electrically connected to said piezoelectric element for acting to attenuate output electric energy.

20. A sheet beam based testing apparatus according to claim 19, characterized in that said vibration attenuating circuit comprises inductive means as an element having an inductance or an equivalent circuit of said element, and is connected to said piezoelectric element having a static capacitance to form a resonant circuit, wherein the

inductance of said inductive means is determined with respect to the static capacitance of said piezoelectric element such that a resonant frequency of said resonant circuit substantially matches a resonant frequency of said mechanical construction.

21. A sheet beam based testing apparatus according to claim 20, characterized by further comprising a resistive element in said vibration attenuating circuit.

22. A sheet beam based testing apparatus according to claim 2, characterized in that a voltage applied to said object under testing can be increased or decreased from zero to a predetermined value, wherein said sheet beam based testing apparatus comprises an electrostatic chuck which is applied at an electrode thereof with a voltage associated with the voltage applied to said object under testing to electrostatically suck and hold said object under testing.

23. A sheet beam based testing apparatus according to claim 22, characterized in that said electrode is divided into a first electrode comprised of a central portion thereof and some of a peripheral portion thereof, and a second electrode comprised of the remaining portion, wherein said sheet beam based testing apparatus comprises an electrostatic chuck for first applying said first electrode with a voltage, placing said object under testing at a low potential or a ground potential, and applying said second electrode with a voltage.

24. A sheet beam based testing apparatus according to

claim 22, characterized in that said electrostatic chuck is comprised of a laminate of a substrate, an electrode and an insulating material, wherein said object under testing is applied with a voltage through a predetermined resistor and a contact, said contact having a shape such that its leading end comes in contact with a back surface of said object under testing.

25. A sheet beam based testing apparatus according to claim 1, characterized by comprising an alignment controller for observing the surface of said object under testing to control alignment for positioning said object under testing with respect to said electron-optical system, and a laser-interference type distance measuring unit for detecting coordinates of said object under testing on said stage, and having a stage control mechanism for determining the coordinates of said object under testing utilizing a pattern existing on said object under testing by means of said alignment controller.

26. A sheet beam based testing apparatus according to claim 1, characterized by having a stage for holding said object under testing with a degree of freedom at least equal to or more than two with respect to said electron-optical system, said stage comprises a non-contact supporting mechanism by means of static pressure bearings, and a vacuum sealing mechanism through differential pumping, and a partition is disposed between a location of said object under testing which is irradiated with the beam and a static pressure bearing support of said stage for

reducing a conductance to produce a pressure difference.

27. A sheet beam based testing apparatus according to claim 26, characterized in that said partition contains a differential pumping structure.

28. A sheet beam based testing apparatus according to claim 26, characterized in that said partition contains a cold trap function.

29. A sheet beam based testing apparatus according to claim 26, characterized in that said partition is disposed at least two locations near a sheet beam generator and near a static pressure bearing.

30. A sheet beam based testing apparatus according to claim 26, characterized in that a gas supplied to said static pressure bearings is dry nitrogen or inert gas.

31. A sheet beam based testing apparatus according to claim 26, characterized in that a gas supplied to said static pressure bearing is exhausted from a housing for containing said stage, and thereafter pressurized and again supplied to said static pressure bearings.

32. A sheet beam based testing apparatus according to claim 26, characterized in that at least surfaces of parts facing said static pressure bearings are applied with a surface treatment for reducing a released gas.

33. A sheet beam based testing apparatus according to claim 1, characterized by comprising a retarding voltage applying unit for applying said object under testing with a retarding voltage, and a control mechanism for applying an optimal retarding voltage, and further having an electron-

optical system including a lens with an insulating material, the surface of which is coated with a metal.

34. A sheet beam based testing apparatus according to claim 33, characterized in that said lens is an axially symmetric lens produced by working a bulk of insulating material.

35. A sheet beam based testing apparatus according to claim 33, characterized in that said control mechanism for applying an optimal retarding voltage has a charging checking function unit for measuring a charge-up state of said object under testing, and a function unit for determining an optimal retarding voltage based on information output from said charging checking function unit to apply said retarding voltage to said object under testing or to change to an optimal beam current.

36. A sheet beam based testing apparatus according to claim 33, characterized in that said charging checking function unit evaluates a charging state of said object under testing based on the magnitude of a distorted pattern or a blurred pattern at a particular site of said object under testing for detecting the secondary charged particle beam to form an image.

37. A sheet beam based testing apparatus according to claim 33, characterized in said charge-up checking function unit can apply said object under testing with a variable retarding voltage, and forms an image near a boundary where a pattern density largely varies on said object under testing which is applied with a plurality of retarding

voltages.

38. A sheet beam based testing apparatus according to claim 37, characterized by comprising an image display device for displaying said formed image such that an operator can evaluate said image.

39. A sheet beam based testing apparatus according to claim 1, characterized by comprising:

an image processing system having image capturing means for capturing each of images of a plurality of regions under testing on said object under testing, and means for storing a reference image; and

an information processing system for comparing said images of the regions under testing with the reference image to determine a state of said object under testing.

40. A sheet beam based testing apparatus according to claim 39, characterized in that said plurality of images of the regions under testing captured by said image processing means are captured as they are displaced from one another while partially overlapping on said object under testing.

41. A sheet beam based testing apparatus according to claim 39, characterized in that said image processing system detects secondary charged particles to sequentially capture images, and has a fluorescent screen and a micro-channel plate.

42. A sheet beam based testing apparatus according to claim 41, characterized in that said image processing system captures a fluorescent image using a solid-state imager device (CCD) camera.

43. A sheet beam based testing apparatus according to claim 1, characterized by comprising beam deflecting means for forming a primary irradiating beam or deflecting the primary irradiating beam to sequentially irradiate regions under testing on said object under testing with the primary irradiating beam.

44. A sheet beam based testing apparatus according to claim 1, characterized in that said object under testing is a wafer or a semiconductor, which is tested for defects thereon.

45. A sheet beam based testing apparatus according to claim 44, characterized in that a target for the testing is at least one selected from defective circuit wires, measurement of line widths, measurement of alignment precision, and measurement of potential contrast.

46. A device manufacturing apparatus characterized by comprising the sheet beam based testing apparatus according to claim 1 for evaluating a wafer or a semiconductor.

47. A sheet beam based testing apparatus according to claim 1, characterized in that said charged particle beam is an electron beam.

48. A sheet beam based testing apparatus according to claim 1, characterized by comprising an electron-optical system for accelerating secondary charged particles using a decelerating electric field type objective lens, and an image processing system for projecting an image thereof.

49. A sheet beam based testing apparatus according to claim 1, characterized by irradiating primary charged

particle beams from a plurality of beam sources instead of said sheet shaped primary irradiating beam, and detecting secondary charged particle beams using a plurality of detectors.

50. A semiconductor device manufacturing method characterized by working, manufacturing, observing or testing a wafer or a semiconductor device using the sheet beam based testing apparatus according to claim 1 for evaluating a wafer or a semiconductor device.

51. An exposure method characterized by delineating a circuit pattern of a semiconductor device on a wafer or a reticle using the sheet beam based testing apparatus according to claim 1.